Optical Device of Scanner

1. **Field of the Invention**:

The invention relates to a kind of scanner, which may proceed flatbed scanning or paper-feeding scan with automatic document feeder, and which particularly relates to a scanner's optical device that may achieve a scanning job without lens set.

2. **Background of the Invention**:

Please refer to FIG. 1, which is an embodiment of a typical flatbed optical scanner 1 commonly seen in current market. Its main structure is that a document window glass 12 is arranged at the upper surface of the casing 11 of a scanner 1 for supporting a document to be scanned (not shown in the figure), and an optical chassis 14 is brought along by a driving device 13 to proceed linear motion along the direction of a guiding rod 15 in the hollow casing 11, such that an image scanning job is executed to the document placed on the glass 12.

Please refer to FIG. 2, which is the A-A cross-sectional view of the optical chassis 14 of an optical scanner 1 of the prior art shown in FIG. 1. The optical chassis 14 includes: a hollow casing 141, a light source 142 positioned at an appropriate position on the upper surface of the casing 141, a light-guiding device comprised by plural reflective mirrors 143, a lens set 144, and a charge coupled device (CCD) 145. The light source 142 first emits light toward the document (not shown in the figure) placed on the glass 12. After the reflected light entering the casing 141 of the optical chassis 14, it is reflected and directionally changed again by plural reflective mirrors 143 of the light-guiding device for increasing its optical length to an appropriate length and, focused by the lens set 144, the reflected light is formed as an image on the charge coupled device 145 that converts the scanned image into electronic signals, and the total track (abbreviated as TT) needed for focusing a clear image is just equal to the total value of $Y1+Y2+\ldots+Y6$ shown in FIG. 2.

Since the lens set 144 of the prior optical chassis 14 shown in FIG. 1 and

FIG. 2 is comprised of the devices, such as convex lens, etc., so the element, the structure, and the assembly all are complicated, and its manufacturing cost is higher, and the lens set 144 will generate light-color separating effect too, such that the scanning quality is influenced and the manufacturing cost is also caused to be increased substantially. All these problems are anxiously to be solved by the relative businesses that manufacture the product of optical scanner.

Summary of the Invention

The main objective of the invention is to provide a scanner's optical device, which applies a light-focusing module for replacing the focusing design of the prior lens set of an optical scanner, such that the objective of reducing the cost of the prior scanner may be achieved effectively.

The secondary objective of the invention is to provide a scanner's optical device, which applies the design of a thin film coated on the light-reflective surface of the light-focusing module, such that the color-light separating phenomenon generated from the refraction of glass may be avoided effectively.

In order to reach the said objectives achievable by the scanner's optical device provided by the invention, the optical device of the scanner may receive the light coming from an object to be scanned, and the optical device is comprised of several reflective mirrors, a light-focusing module, and a charge coupled device.

The reflective mirror may provide reflection and directional change for the light and, by arranging several reflective mirrors appropriately, the light of the object to be scanned may be directionally changed to a predetermined route.

The light-focusing module at least includes: at least one curving mirror and a raster. The curving mirror may focus the light of the predetermined route and then directionally change it, and the raster is provided in the light route of the curving mirror for filtering out unnecessary light.

The charge coupled device may receive the light coming from the light-focusing module and convert it into electronic signals.

In another preferable embodiment of the invention, wherein the reflective mirror is adjustable and, by adjusting the relative positions of the several reflective mirrors, an optical length for proceeding scanning function may be changed, and the several adjustable reflective mirrors are arranged appropriately, such that the light of the image of the object to be scanned is directionally changed to a predetermined route.

For your esteemed reviewing committee to further understand the operational principle and the other function of the invention in a more clear way, a detailed description in cooperation with corresponding drawings is presented as follows.

Brief Description of the Drawings

FIG. 1 is an illustration of an optical scanner according to the prior arts.

FIG. 2 is an illustration for the light-guiding device inside the optical chassis of the optical scanner according to the prior arts.

FIG. 3A illustrates the upper view, the front view, and the side view of the No. 1 concave mirror according to the invention.

FIG. 3B illustrates the upper view, the front view, and the side view of the No. 2 concave mirror according to the invention.

FIG. 3C illustrates the upper view, the front view, and the side view of the No. 3 concave mirror according to the invention.

FIG. 4A is an illustration for the first embodiment of the raster according to the invention.

FIG. 4B is an illustration for the second embodiment of the raster according to the invention.

FIG. 4C is an illustration for the third embodiment of the raster according to the invention.

FIG. 5A is an illustration for the first preferable embodiment for the optical route of the optical device of the optical scanner according to the invention.

FIG. 5B is an illustration for the second preferable embodiment for the optical route of the optical device of the optical scanner according to the invention.

FIG. 5C is an illustration for the third preferable embodiment for the optical route of the optical device of the optical scanner according to the invention.

FIG. 6 is an illustration for a preferable embodiment for the connecting structure between the casing and the concave mirror of the optical device according to the invention.

FIG. 7 is a partially enlarged 3-D illustration for the A zone shown in FIG. 6.

Detailed Description of the Invention

The main characteristic of the optical device of the scanner according to the invention is to give up the lens set that focuses light into image used in the traditional scanner, instead at least one curving mirror being used for proceeding the light to be formed as an image on a charge coupled device that in turn converts the image into electronic signals; furthermore, a raster is cooperated to separate unnecessary light for providing better image's quality and, since the invention unnecessarily uses any lens set, so it has lower cost and advantage of no generation of light-color separating phenomenon.

In order to describe the detailed means, motion manner, achievable function, and other technical characteristic of the invention, several preferable embodiments will be presented as follows.

To describe the technical characteristic and the executing manner of the invention, several executing patterns for the curving mirror and the raster of the invention will be introduced first.

As shown in FIG. 3A, FIG. 3B, and FIG. 3C, which are three executing patterns for the curving mirrors of the invention: the No. 1 curving mirror 32a, the No. 2 curving mirror 32b, and the No. 3 curving mirror 32c.

As shown in FIG. 3A, in which the No. 1 curving mirror 32a has a surface similar to circular pillar or straight barrel, and the No. 1 curving mirror 32a has two parallel long sides (i.e., the first long side 321a and the second long side 322a), two short sides (i.e., the first short side 323a and the second short side 324a) that are intercrossed with the two long sides, and the two planes (i.e., the first plane 325a and the second plane 326a) that are corresponded to each other and are defined by each long side and each short side respectively. On the No. 1 curving mirror 32a, by bending the two short sides 323a, 324a toward same side direction and keeping the two long sides 321a, 322a still, it may make the first plane 325a bent inwardly and the second plane 326a projected outwardly, such that the No. 1 curving mirror 32a is formed.

As shown in FIG. 3B, in which the No. 2 curving mirror 32b has a surface similar to circular ball or elliptic ball, and the No. 2 curving mirror 32b has two parallel long sides (i.e., the first long side 321b and the second long side 322b), two short sides (i.e., the first short side 323b and the second short side 324b) that are intercrossed with the two long sides, and two planes (i.e., the first plane 325b and the second plane 326b) that are corresponded to each other and are defined by each long side and each short side respectively. On the No. 2 curving mirror 32b, by bending the two short sides 323b, 324b and the two long sides 321b, 322b toward same side direction, it may make the first plane 325b bent inwardly and the second plane 326b projected outwardly, such that the No. 2 curving mirror 32b is formed.

As shown in FIG. 3C, in which the No. 3 curving mirror 32c has a surface similar to circular pillar or straight barrel, and the No. 3 curving mirror 32c has two parallel long sides (i.e., the first long side 321c and the second long side 322c), two short sides (i.e., the first short side 323c and the second short side 324c) that are intercrossed with the two long sides, and two planes (i.e., the first plane 325c and the second plane 326c) that are corresponded to each other and are defined by each long side and each short side respectively. On the No. 3 curving mirror 32c, by bending the two

long sides 321c, 322c toward same side direction and keeping the two short sides 323c, 324c still, it may make the first plane 325c bent inwardly and the second plane 326c projected outwardly, such that the No. 3 curving mirror 32c is formed.

In one preferable embodiment, each curving mirror 32a, 32b, 32c of the invention may be structured as thin plate made of non-glass and flexible materials, and three coating layers 327a, 327b, 327c made of light-reflective materials are arranged and distributed over the inner curving surfaces of the thin plates (i.e., the first surfaces 325a, 325b, 325c) for providing the function of light-reflective surface. Wherein, the light-reflective materials of the coating layers 327a, 327b, 327c may be silver, chromium, aluminum, platinum, or other materials with good light reflectivity, which all may be formed on the thin plate by evaporating sputtering, sputtering, chemical deposition, or other manners, and the thickness of each coating layer 178,188, 198 may be single layer or may be multi-layer. Furthermore, the material of the thin plate may be one of the following kinds of material, such as: paper, plastic, resin, macromolecular polymer, glass fiber, rubber, metallic film, or other non-glass of flexible material. One thing is worth mentioning: the so-called flexible material is not referred to extremely soft material, but a material that should have appropriate hardness capable of keeping the thin plate itself maintain enough planarity to reach an excellent effectiveness of light reflection but, subjected to external forces, it still may be bent to certain degree to constitute the curving mirrors 32a, 32b, 32c with a specific curvature but not going to be broken and, on the other hand, the flexible materials may also be easily manufactured into different formations relatively, such that its application field may be relatively wider.

As shown in FIG. 4A, FIG. 4B, and FIG. 4C, which are three illustrations respectively for three different preferable embodiments for the raster according to the invention. In FIG. 4A, the raster 33a has a circular transparent hole 331a, of which the radius is commonly between 2~6mm preferably. Except the transparent hole 331a, other part of the raster 33a is necessarily comprised of opaque material. The main reason for restricting the size of the transparent hole 331a is that, if the radius of the transparent hole 331 is too large, then it is impossible to provide excellent separation function for unnecessary light and, if the radius is too small, then it is easy

to generate light-diffracting phenomenon, so the size of the transparent hole 331a of the raster 33a must be restricted within specific range, such that a preferable quality of scanned image may be provided. In FIG. 4B, the transparent hole of the raster 33b is a transparent hole 331b shown as a long narrow stripe and extended horizontally. The width (i.e., the narrower side) of this transparent hole 331b shown as long narrow stripe is commonly between 2~6mm preferably. In FIG. 4C, the number of the transparent hole 331c of the raster 33c is plural and each transparent hole 331c is shown as long narrow stripe and extended horizontally, and the width or the radius of each transparent hole 331c is commonly between 2~6mm preferably.

Please refer to FIG. 5A to FIG. 5C, which are illustrations respectively for several preferable embodiments for the optical route of the optical device of the scanner according to the invention. As shown in FIG. 5A, when the optical scanning device 2 of the invention intends to proceed a reflective scanning mode on an object to be scanned 8, the light image reflected from the object to be scanned 8 enters an optical device 3; at this time, the optical length of the light emitted from the light source 21 and proceeding to the object to be scanned 8 is Y1'; when the optical scanning device 2 intends to proceed a paper-feeding scanning mode on an object to be scanned 8a, the object to be scanned 8a is located little higher than the position of the original object to be scanned 8, so the light emitted from the first light source 21 and incident upon the object to be scanned 8a is then reflected from the object to be scanned 8a and enters the optical device 3; at this time, the optical length of the light emitted from the first light source 21 and entering the object to be scanned 8a is Y1"; when the optical scanning device 2 intends to proceed a transparent scanning mode on an object to be scanned 8, a light emitted from a second light source 22, incident toward the object to be scanned 8, and penetrating through it enters the optical device 3; at this time, the optical length of the light emitted from the second light source 22 and incident upon the object to be scanned 8 is Y1'".

In the preferable embodiment of the invention, the optical device 3 of a scanner may receive the light of the image coming from an object to be scanned 8, wherein the optical device 3 includes: several reflective mirrors 31, a light-focusing module 30, and a charge coupled device 34. The reflective mirror 31 is provided for reflecting and directionally changing the

light and, through appropriately arranging the several reflective mirrors 31, the light of the image of the object to be scanned 8 is directionally changed to a predetermined route. With at least one curving mirror 32, the light-focusing module 30 focuses the light of the predetermined route and directionally changes it to the charge coupled device 34, which receives the light directionally changed by and coming from the light-focusing module 30 and converts it into electronic signals, and the light-focusing module 30 further has a raster 33, which is located in the optical route of the curving mirror 32 and is applied for filtering out the unnecessary light.

In the preferable embodiment shown in FIG. 5A, the arranging manner of the optical path is to apply three reflective mirrors 31 to proceed reflection and directional change to the light of the image coming from the object to be scanned 8 to be guided to a predetermined route, and the optical length is thereby elongated, while the reflective mirror 31 has no light-focusing function. The difference between the preferable embodiment of FIG. 5B with that of said FIG. 5A is that: this embodiment applies more piece (five pieces) of reflective mirror 31a and appropriate design of optical route to obtain an optical device 3a with smaller volume under the condition of equal total track; while the difference between the preferable embodiment of FIG. 5C with that of said FIG. 5A is that: this preferable embodiment applies less piece (two pieces) of reflective mirror 31b and appropriate design of optical route to make the optical device 3b formed into a three-dimensional structure.

In this preferable embodiment of the invention, the number of the curving mirror 32 of the light-focusing module 30 is two. One is used to receive the light image transferred from the predetermined route, focus it, and then transfer it again. The other one transfers the light focused and transferred by the said mirror 32 to the charge coupled device 34. In this preferable embodiment, both the curving mirrors 32 have same curvature respectively. Of course, in order to enhance the brilliance of the scanned image, it may also be possible to design these two curving mirrors 32 into two curving mirrors 32 that have different curvatures respectively, while the raster 33 is located in optical route that may be between the charge coupled device 34 and the curving mirror 32, the reflective mirror 31 and the curving mirror 32, or the curving mirror 32 and the curving mirror 32, etc. In the

preferable embodiment, the transparent hole 331 of the raster 33 is located in the optical route at the position of the neighborhood of the focusing point, such that a better function for filtering unnecessary light is provided. When different scanning modes are undertaken, the scanning quality will be influenced because of the different optical lengths such as Y1', Y1'', or Y1''' so, preferably, the optical device 3 may further be arranged with an image adjustable module 35, such that the light image focused by the curving mirror 32 may be calibrated and adjusted. Of course, by designing the reflective mirror 31 to be adjustable, the relative positions of the several reflective mirrors 31 may be adjusted for changing an optical length of a scanning procedure. The several adjustable reflective mirrors 31 have been arranged appropriately, such that the light of the image of the object to be scanned 8 is directionally changed to a predetermined route.

Please refer to FIG. 6 and FIG. 7, which illustrate a preferable embodiment for the connecting structure between the casing and the concave mirror of the optical device according to the invention. The optical device 3 of the invention is further comprised of a casing 4 available for accommodating and positioning the reflective mirror 31, the light source 21, the light-focusing module 30, and the charge coupled device 34. Furthermore, several connecting surfaces 41 are formed with corresponding predetermined angles and positions at the predetermined positions on the side surfaces in the casing 4 for providing the connecting and positioning functions to the curving mirror 32 and the reflective mirror 31. Additionally, the connecting surface 41 is designed as a curving formation with appropriate curvature for matching the curving outer appearance of the curving mirror 32, such that the curving mirror 32 may be directly accommodated and positioned in the connecting surface 41. As described therein before, since the curving mirror 32 may be preferably comprised of a flexible material, so it may be connected and combined on the connecting surface 41 by any direct connecting method to comprise the curving mirror 32, and an open groove 42 may be further arranged for accommodating the raster 33. Therefore, when the optical device 3 is assembled, it may just directly paste and position the light-reflective element formed as thin plate that is manufactured by flexible materials and is coated with light-reflective layer onto the connecting surface 41 formed as curving surface in the casing 4, so the structure of the curving mirror 32 may be directly formed with very

easy, time-saving procedure and low cost. Furthermore, it is very easy to machine, bend, or design the flexible thin-plated structure made of non-glass materials into a light-reflective device with curving surface or irregular shape available for special requirement.